Characterization of Scaled SONOS EEPROM Memory Devices for Space and Military Systems*

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We present recent results on an integrated radiation-hardened technology, which consists of scaled Silicon-Oxide-Nitride-Oxide-Silicon (SONOS) nonvolatile semiconductor memory (NVSM) and bulk CMOS devices – devices designed specifically for high-density, 1-4Mb EEPROMs operating in space and military environments. These devices operate at low-voltage (+7V, 2.5 ms write, -7V, 7.5 ms erase) with 10-year retention at 150C and greater than 10^5 erase/write cycles. We describe erase/write, retention and endurance results over a 22 – 250C temperature range with a tunnel oxide of 1.8 nm, 'oxynitride' of 6.5 nm, and a blocking or 'cap' oxide of 3.0 nm. These scaled SONOS devices exhibit an extrapolated 10-year memory window of 1.2V (22C) and acceptable 0.3V (150C). A SONOS retention model is presented, which includes charge loss from both direct tunneling and thermal excitation. We discuss recent results of a radiation-hardened 1Mb SONOS EEPROM and its memory cell. We discuss experiments on 'localized' charge storage with hot electron injection to write SONOS/NROM™ memory devices for higher functional density with increased retention. In addition, we present a new model, based on measurements in the subthreshold region of NVSM arrays, for determining threshold voltage distributions and their variances in both SONOS and NROM™ transistor arrays.

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